7

The Expanding Percentage of Women among Corporate Science and Technology Human Resources – EU Policies and Japanese Issues–

YUKO ITO
Life Science and Medical Research Unit

1 Introduction

Sponsored by Germany's Federal Ministry of Education and Research and the European Commission, the Women in Industrial Research (WIR) conference was held on October 10 and 11, 2003, in Berlin's Dresdner Bank. The conference discussed topics such as the significance of support for female researchers (engineers)[*1] in industry, results and analysis of statistical surveys carried out in the EU, and policies to increase the number of female researchers (engineers). The conference was an international one, with 300 registered participants drawn not only from the EU but from all over the world. The high level of interest in the subject was made clear.

Women in Industrial Research (WIR) is a research program within Women and Science, a part of Science and Society in Europe (€80-million budget) in the EU's Framework Program 6 (FP6, 2002-2006). The WIR specialist group gathers and analyzes statistics on female researchers (engineers). In 2003 it published two reports, "A wake up call for European Industry[1]" and "Analysis of statistical data and good practices of companies[2]."

In addition to WIR, the other Women and Science programs are Mainstreaming Gender and Collecting Statistics in FP6, the Helsinki Group on Women and Science, Women and Science Networks, Sex-disaggregated Statistics and Indicators on Women Scientists, and Promoting Gender Equality in Science in a Wider Europe (see Table 1). In this way, Europe is advancing policies on "Women and Science" not just at the national level but also at the EU and European levels.

In Japan, a policy research program under the science and technology policy advice program for fiscal 2001-2002 science and technology new adjustment funds was implemented in the form of survey research focusing on female researchers in science and technology. The program issued

Table 1:FP6 Science and Society programs*

Program	Content or included programs
Young people and Science	• EU Young Scientists Contest (ages 15 to 20) • Young Women Scientists Contest
Women and Science	• Mainstreaming Gender and Collecting Statistics in FP6 • The Helsinki Group on Women and Science • Women and Science Networks • Sex-disaggregated Statistics and Indicators on Women Scientists • Women in Industrial Research (WIR) • Promoting Gender Equality in Science in a Wider Europe
The Science and Society Action Plan	Thirty-eight actions, including: • Promoting scientific education and culture in Europe • A science policy closer to the citizens • Responsible science at the heart of policy making

*In addition to the above, Science and Society also includes programs on Science and Governance, Ethics, and Scientific Awareness.
Source: Author's compilation based on "EU Sixth Framework Program" (http://www.cordis.lu/fp6/society.htm)

a science and technology policy advisory report, "Developing the ability of female researchers in science and technology fields," in March 2003. The survey research focused on female researchers and engineers at universities and research institutes. The implementation of such policy research programs is highly significant, and it is to be hoped that such large-scale research will continue with its focus expanded to include female researchers and engineers in private industry as well.

This article will discuss the EU's experiments with the fostering and promotion of female researchers and how Japan could adapt that experience into a comprehensive science and technology human resources policy.

2 Why does the EU focus on female researchers?

Underlying the attention that the EU pays to female scientists is the advent of an era of global competition in science and technology. The status of advances in science and technology has come to impact societies and economies.

The following two reasons create the necessity for and form the background underlying the EU increasing the number and percentage of female researchers.

(1) Strengthening the competitiveness of the EU

At the 2000 Lisbon Summit, it was declared that the EU would become the world's leading intellectual-base economic body, and at the 2002 Barcelona Summit it was determined to raise research and development spending in the EU from 1.9 percent of GDP to 3 percent by 2010. The EU is therefore studying how to raise the number of researchers in the EU as a whole by 500,000[*2].

(2) Economic activation

Women pay attention to women as a market of consumers and develop products that meet women's needs and attract their interest. This is expected to result in increased domestic consumption and the development of new industry.

The EU considers policies towards science and technology human resources important in achieving such "strengthened competitiveness" and "economic activation." It emphasizes the need to increase the percentage of female researchers on these grounds also:

- Ensuring outstanding human resources
- Introducing diversity into human resources

There is an increasing need for human resources who welcome this era of global competition, have multiple skills, are highly creative, can respond innovatively across disciplines, can create new ideas and businesses, and will become a driving force for diversity.

The EU has the following ideas regarding concrete steps to improve the insufficient development of outstanding science and technology human resources and to increase the percentage of female researchers.

(a) Improved work environments

The lifestyles of young people (both men and women) are changing, and when choosing a place to work they are tending to look for fluidity (adaptability) of balance between work and life, and for fully-realized systems. In order to secure the outstanding science and technology personnel of the next generations, current deficiencies in systems must be improved.

Progress on workplace environments (childcare and family leave, for example) varies among the countries of Europe, and in comparison with the United States this becomes an obstacle in the flow of outstanding personnel into Europe and their retention there.

(b) Finding new points of difficulty by analyzing successful cases

The percentage of women grows smaller at each step up the career ladder. Polices to increase the percentage of women at the top can be found in companies that have succeeded in bringing women into the tops of their hierarchies.

3 International comparison of the percentage of female researchers

In order to better understand the status of female researchers, I compared the percentage of female researchers among all researchers in various countries.

3.1 Percentage of female researchers

Figure 1 shows the percentage of female researchers among researchers in all fields. While the percentage of researchers who are female in Japan is about 10 percent, in Europe it ranges from 25 to 40 percent.

Because the percentage of female researchers is likely to be connected to the percentage of women among graduates from university science and technology departments and recipients of PhDs, Figure 2 shows the percentages of such women in Japan and the EU.

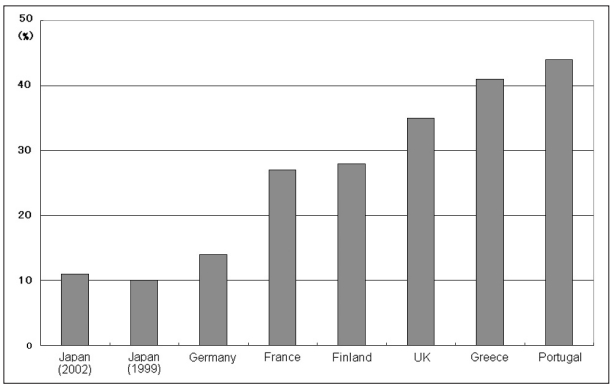
The percentage of women among graduates of university science and technology departments in Japan is approximately the same as in Germany, while it is about 10 percentage points below that of France, the UK, and the EU 15.

As described in section 5 below, Germany has worked out a policy emphasizing "researcher development" to increase the percentage.

3.2 Percentage of female researchers in industry

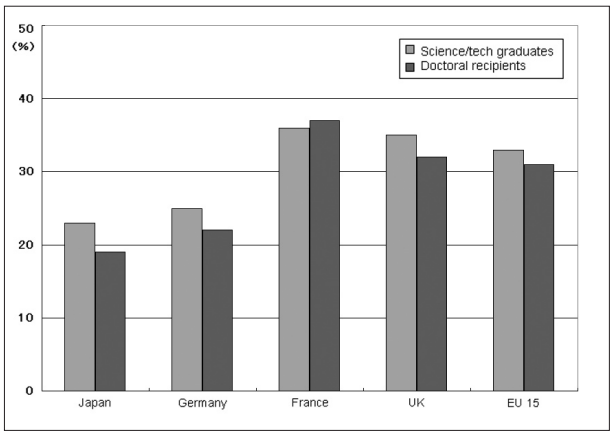
What is the percentage of females among researchers attached to corporations? Figure 3 shows the percentages of researchers who are

Figure 1:International comparison of percentage of female researchers (1999)



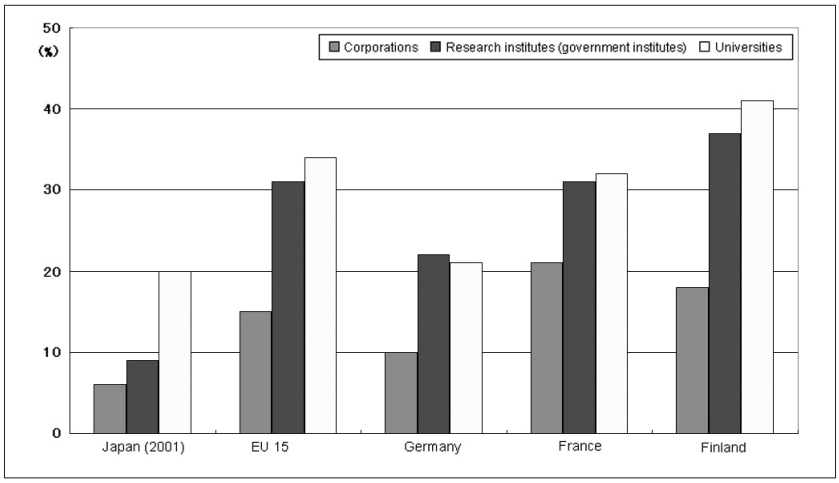
Sources: Author's compilation based on "She Figures 2002", Science and Society, European Commission and "Survey of Research and Development", Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications.

Figure 2:Percentage of women among graduates of science and technology departments and recipients of doctoral degrees



Sources: Author's compilation based on Reference[2] and FY 2002 Basic Survey on Schools.

Figure 3:International comparison of female researchers by sector (2000)



Source: Author's compilation based on "She Figures 2002," Science and Society,European Commission.

female by sector in Japan, three EU countries and EU15.

The percentage of researchers who are female in all three sectors-universities, research institutes (government institutes), and corporations-is much lower in Japan than in the EU. Within the EU, Germany has the lowest percentage of female researchers in all three sectors, while Finland has the highest in each.

Comparing the percentage of females by sector, universities have the highest percentage. The average for the EU 15 is 34 percent, and 44 to 46 percent of researchers at universities in Ireland, Portugal, and Greece, which are not included in the chart, are female.

The percentage of researchers who are female is lowest in the corporate sector in each country. The average in the EU 15 is 15 percent, while in Japan it is only 6 percent.

4 EU experiments to increase the percentage of female researchers

Although, as described in section 3 above, the percentage of EU researchers who are female is significantly higher than in Japan, there is a sense of crisis concerning the situation in the EU, and, as mentioned in section 2 above, the EU is undertaking a number of experiments to improve it.

The following policies can be considered in order to increase the number of female researchers in corporations: 1) Fostering of female researchers by corporations and 2) improving the corporate environment. Furthermore, In order to understand current conditions and any progress that is made, 3) statistical research can also be considered important.

Below I will describe some examples of programs.

4.1 Fostering of female researchers by corporations

(1) Cases in Germany

As can be seen in both Figure 2 and Figure 3, Germany has a lower percentage of women proceeding with science and technology study compared to the EU 15 as a whole, and the percentage of researchers who are female in corporations is also low. A number of national programs related to increasing the number of women majoring in information technology fields and working in corporations are therefore underway (see Table 2).

Expectations for Girls Day, which has been held since 2001 with support from Germany's Federal Government and elsewhere, as a policy to foster future human resources in science and technology fields are particularly high. Last Girls Day, May 8, 2003, 100,000 girls at 10 and older

Table 2:Current major German programs to foster female researchers

Program name	Purpose	Targets	Website
Women in the Information Society and in Technology	To increase the number of women majoring in science, technology, and computer science	Young women	www.kompetenzz.de
Be.ing – in Future together with Women	To increase the percentage of women in information technology (IT) fields	Young women	www.be-ing.de
be.it	To increase the percentage of women in IT fields	Young women	www.werde-informatikerin.de
Do.ings	To support higher education for women who choose science and technology courses	Female children and students	www.do-ing.rwth-aachen.de
Initiative D21	To increase the percentage of women in IT fields	Young women	www.initiatived21.de
Girls@D21	To increase understanding of the jobs of IT specialists	Female children and students	www.girls-d21.de
Girls Day	To increase opportunities to find out about corporate jobs through corporate visits	Female children and students	www.girlsday.de
Chemistry in Context	To increase the number of female university students who study chemistry	Female children and students	www.chik.de

Source: Author's compilation based on Reference[4]

visited 3,905 research centers, corporations, and offices.

(2) Cases in the UK and the USA

Similar to the German program are the Take Our Daughters to Work programs in the UK and the USA. The US program began 10 years ago, while that of the UK began on April 3, 2003. The purpose of the programs is to show girls who may only be thinking of traditionally female jobs a variety of workplaces and jobs. They are intended to broaden girls' options when they choose jobs in the future.

The US program was revised on April 24, 2003, becoming Take Our Daughters and Sons to Work. According to the sponsors, that is because the goals for girls in the US have been achieved.

4.2 Improvement of workplace environments in corporations

Corporations that provide workplace environments comfortable for all workers can be considered as providing the same for researchers as well. To promote the improvement of workplace environments, the European Commission holds the Great Places to Work contest. On March 27, 2003, it announced the latest list of the 100 most outstanding companies (www.eu100best.org). Many of the 100 companies carry out research as their primary business. The list is the result of a survey of over 210,000 people (about 124,000 valid responses) who work for more than 1,000 organizations within the 15 EU countries. Eleven nominated companies are chosen from the results of the survey, and the best are finally chosen after further judging. In the 2003 contest, the legal firm Hannes Snellman (Finland) was chosen as best in the Lifelong Learning category, IT company Intel (Ireland) in the Diversity category, and pharmaceutical corporation Schering (Germany) in the Gender Equality category.

The magazine The Scientist also surveyed its readers (most of whom are researchers) regarding the quality of their workplace environments, and the results were announced in June 2003[9].

The abovementioned WIR also carried out survey research (including individual interviews) regarding workplace environments, and the results were made public[3]. The survey asked: 1) If company managers are carrying out "gender equality," "human resources diversification," and "maintenance of dignity in the workplace." 2) If the company carries out supervision, evaluation analysis, statistical surveys, and advice regarding gender equality. 3) If the company welcomes innovation and provides fulfilling career opportunities. 4) If hiring, promotion, and evaluation practices are fair and open. 5) If work schedules are flexible. 6) If childcare and family leave and facilities related to them are available. 7) If there are programs (internships and fellowships) to help young women enter scientific fields. 8) If there are women's networks. Table 3 shows data regarding women researchers made public after a WIR survey. Data are from one or two companies that cooperated with the survey in each sector.

Along with providing incentives for workplace improvement, the results are likely to be considered by young people (both men and women) seeking employment. Corporations are therefore likely to become more aware of the issue of workplace improvement.

It is to be hoped that in the future Japanese corporations will also make public the status of their utilization of women researchers.

5 The corporate need for researchers and current conditions in Japan

This section will discuss current conditions for researchers in Japanese corporations and consider the possibilities for the utilization of women as science and technology human resources.

5.1 A perception of too few researchers in corporations

In September 2003, the results of a survey of approximately 2,000 corporations that carry out research and development activities and are estimated to be capitalized at ¥1 billion or more were reported in the "The Survey on Research Activity of Private Business (FY2002)" (Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology). The survey results included

data regarding science and technology human resources such as researchers.

The report indicated a shortage of science and technology human resources (see Figure 4). Of 1,061 companies responding, 40 percent answered "Insufficient" regarding their "Researcher" human resources.

Research sectors in which close to 30 percent of companies reported a shortage of researchers are Information and Communications, Manufacturing Technology, and Nanotechnology and Materials (see Figure 5).

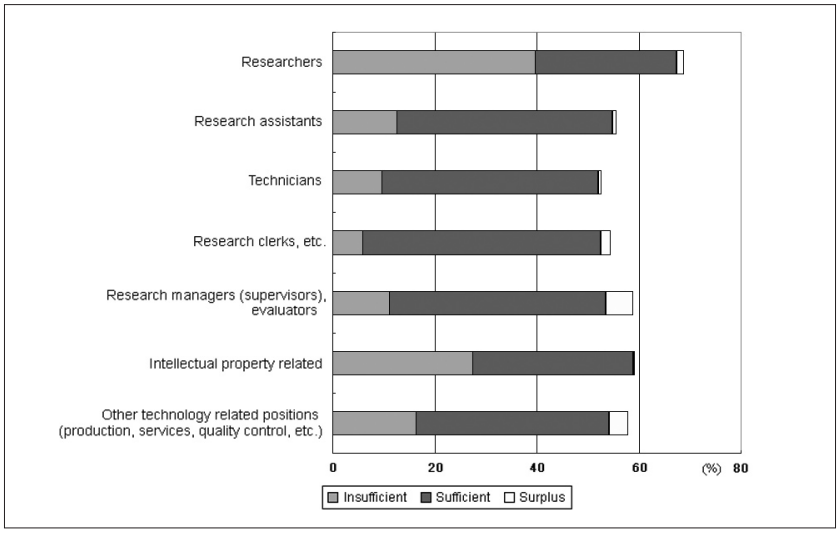
Of corporations reporting a shortage, 45 percent chose "The total number of researchers is small due to employment conditions and other factors" or "Because of the diversification of specialties, there are not enough researchers, including new graduates, to handle them" as the reason.

Table 3:Utilization of women in major corporations

Company (headquarters country)	Sector	Number of researchers	Number of female researcher (percentage)	Number of female research managers (percentage)	Percentage of patent applicants who are female
AstraZeneca (UK)	Pharmaceuticals	10,000	5,000 (50%)	29% (of research supervisors)	17%
Schering AG (Germany)	Pharmaceuticals	480	140 (29%)	27 (17%)	
DSM (Netherlands)	Life sciences	2,000	400 (20%)	1 (0.5%) R&D director, 20 (20%) resource managers, 50 (10%) project managers	
Ford European Research Center (Germany)	Automobile manufacturing	272	16 (6%)	3 (5%)	1 of 43 patent applications
Schlumberger, worldwide (USA, France, Netherlands)	Petroleum	3,308 (including engineers)	614 (19%) (including engineers)	47 (9%)	
Siemens AG, worldwide (Germany)	Energy	53,100	7,400 (14%) (including engineers)	8.6%	

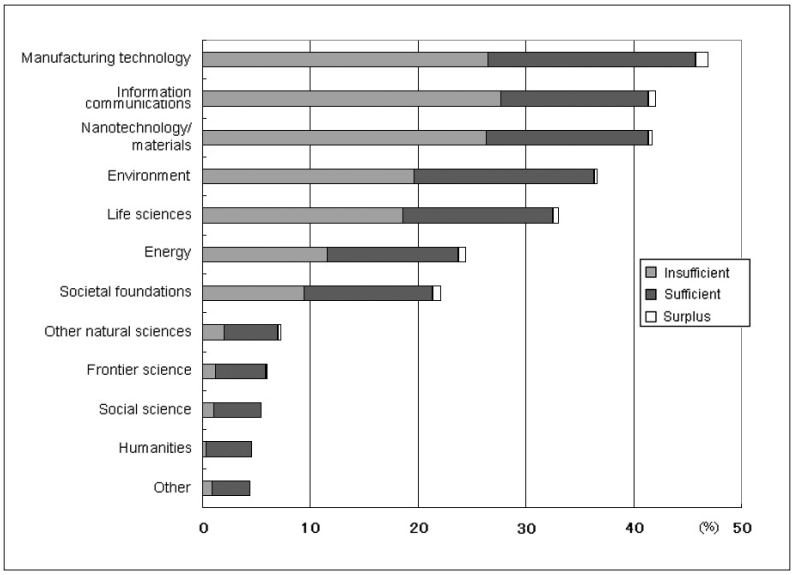
Source: Author's compilation based on Reference[3]

Figure 4:The shortage of science and technology personnel in Japan (percentage of 1,061 corporations responding)



Source: Survey on Research Activity of Private Business (FY2002)
(Science and Technology Policy Bureau, Ministry of Education,Culture, Sports, Science and Technology)

Figure 5:The shortage of researchers in Japan (percentage of 1,061 corporations responding)



Source: "Survey on Research Activity of Private Business (FY2002)"
(Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology)

5.2 *Changes visible in the utilization of female researchers by corporations*

Can the deficiency of researchers shown in Figure 5 be made up for by female researchers?

Figure 6 shows trends in the number of women researchers and can help answer that question. Most Japanese women researchers in corporations are in the chemicals, electrics and communications, and pharmaceutical sectors. Looking at trends over the 20 years since 1981, the increase in women researchers in electrics and communications is remarkable. The number of female researchers has increased markedly in the past 5 years as well. This trend continued in fiscal 2001 and 2002, with a reported increase of about 1,000 female researchers in 1 year. Furthermore, in electrics and communications, the percentage of researchers who are female increased from 2 percent in 1996 to 4 percent by 2002.

In the Information and Communications sector (in the survey, including information, communications systems, electrical, electronics, computers, etc.), shown in Figure 5 to perceive a shortage of researchers, and in the identical electronics and communications sector, a strong upward trend in the number of female researchers can be seen. It is likely that corporations are actively employing female researchers in sections experiencing shortages.

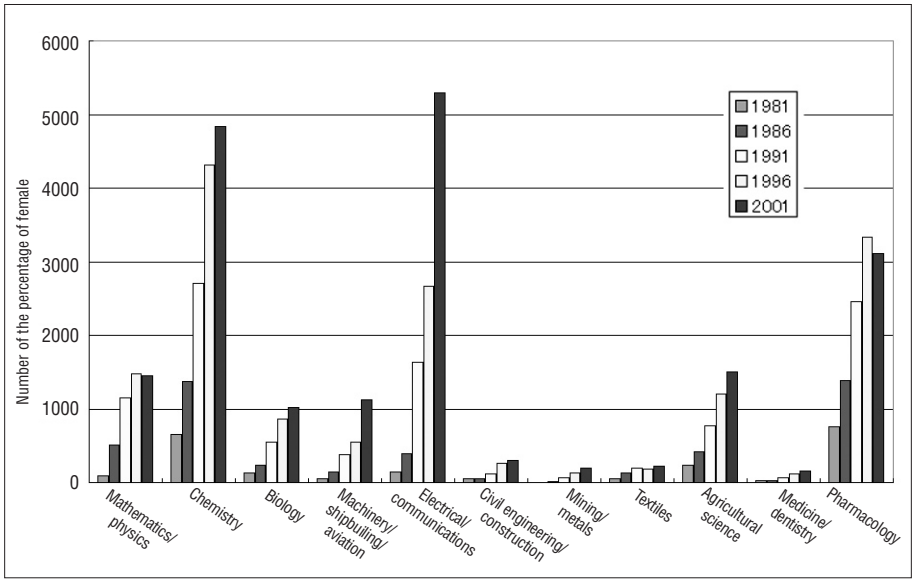
In universities, the most common fields for female researchers are medicine and dentistry, while in laboratories and other research institutes agriculture is the most common field for women researchers. Both universities and research institutes have seen increases in the 20 years since 1981. In this way, the fields in which women researchers have increased have differed among corporations, universities and research institutes.

Because corporations must respond quickly to advances in science and technology, it appears that they are tending over the past few years to employ human resources who meet their needs without regard for gender.

5.3 *Gender gap visible in work performed by researchers*

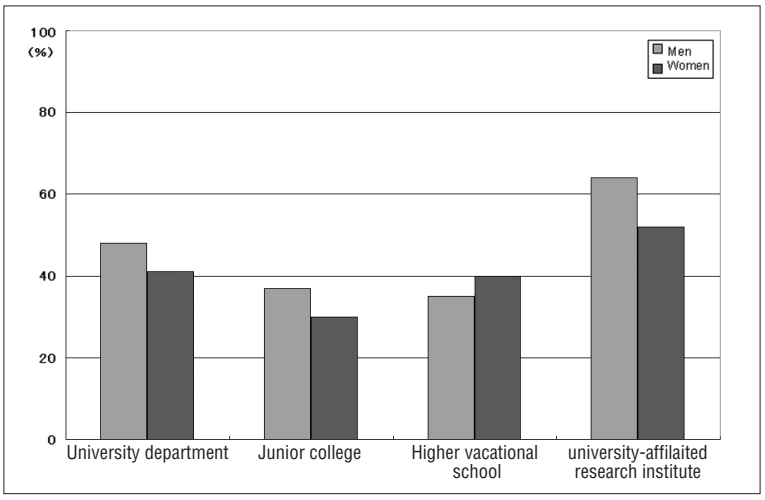
The amount and percentage of time spent on research will vary among researchers. The work of some researchers will primarily be research, others will have some additional duties, while still others will hold an additional post other than research. The non-research activities of university researchers include education (teaching, advising students, and so on) and societal activities (consulting, transferring technologies resulting from research, and so on). The non-research work of corporate researchers may include management duties and patent-related tasks. To understand the status of researchers' activities,

Figure 6:Trends in female researchers by sector (corporations)



Source: Author's compilation based on "Survey of Research and Development," Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications

Figure 7:Comparison of percentage of all work time spent on research by gender and type of institution



Source: Author's compilation based on "Report on the survey of FTE Data on Researchers in the Higher Education Sector," Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology)

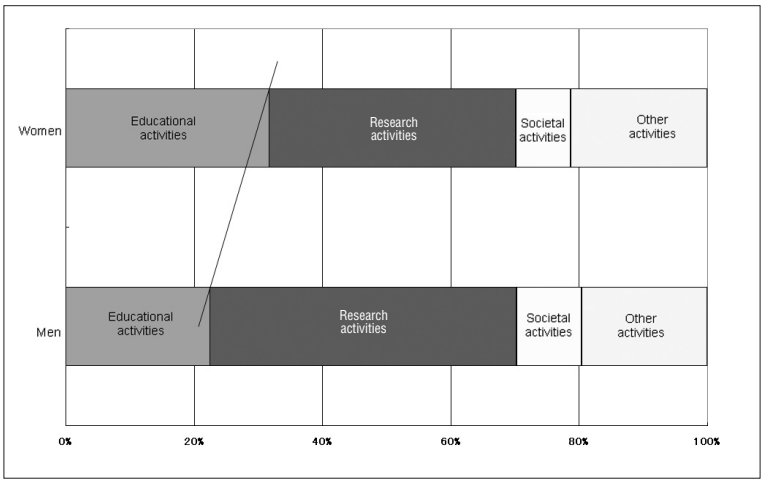
factors such as their work duties and time spent on research must be surveyed.

The Report on the survey of FTE Data on Researchers in the Higher Education Sector (Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology) was published in November 2003. Educators (professors, assistant professors, lecturers, and assistants) at randomly selected colleges (including junior colleges, higher vocational schools, and university-affiliated research institutes) were surveyed regarding the content of their work, such as "Research activities" and "Educational activities," and the amount of time put into it. Respondents numbered 6,090 men and 1,088 women, and the results showed a difference in time spent on research by men and women.

As shown in Figure 7, when the research hours of men and women are compared by university department, junior college, or university-affiliated research institute, women spend a smaller percentage of their time on research than men do.

To compare the time spent by men and women on non-research activities, Figure 8 shows a breakdown of the annual work hour usage, which demonstrates a gender difference. Women spend less of their time (39 percent) than men (48

Figure 8: Breakdown of annual work hours (percentage) by gender



Source: Author's compilation based on "Report on the survey of FTE Data on Researchers in the Higher Education Sector," Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology)

percent) on research activities, and more than men on educational activities (32 percent and 22 percent, respectively).

The causal factors of this difference are unclear, as is the question of whether it disadvantages the promotion and advancement of women. Detailed analysis of those points is needed. First, however, research to determine how many female researchers are employed by corporations and whether their actual duties differ from those of men in the same jobs is required.

6 Conclusion and proposals

The development and use of science and technology human resources that are the driving force behind breakthroughs and scientific and technological advances constitutes an important policy for advanced countries.

In Europe, it is believed that "A society of clones will only produce cloned ideas." With "Escape from a clone society" and "Moving towards a diverse society" as keywords, polices to create diversity by increasing the percentage of women among science and technology human resources are being implemented. The United States, which holds to the ideal of a "diverse society" that incorporates women and various races and is one of the first in the world to become such, leads the world in science and technology.

In Japan as well, "diversity" is now seen as important in science and technology and society, and the activities of women in various sectors of society are noteworthy. The number of female researchers has indeed increased over the past 10 years. However, women as a percentage of all researchers have remained at about 10 percent for several years, and there is no sign that this will change. Moreover, in corporations, only 6 percent of researchers are female.

The percentage of researchers in the EU is double or triple that of Japan. Despite that fact, the EU believes it is necessary to increase the percentage of female researchers to 30 percent in corporations to build "diversity," and it is undertaking various initiatives to do so.

It is difficult to estimate the optimal percentage of female researchers for Japanese corporations. One idea is that raising the percentage in Japan to the EU's current level should be Japan's goal for the time being. It should be possible for Japan to consider national policies in reference to those of the EU.

Below I discuss issues for Japan and some possible measures.

Issues

(1) The percentage of women in science and technology fields among university graduates and PhD recipients is low.

(2) The percentage of corporate researchers who are women is low.

(3) There is no national body like Women and

Science of the EU's Framework Program 6 to implement comprehensive programs for statistical surveys related to women and science, academic research, or research-support grants.

Policies regarding issue (1)

- Foster female human resources in science and technology from school age

Plan a Japanese version of Girls Day and Take Our Daughters to Work, increase opportunities for girls to dialog with researchers and engineers and to visit science and technology facilities, awaken girls' interest in science and technology, and secure and foster future science and technology human resources.

Policies regarding issue (2)

- Carry out survey research regarding women who do research in corporations

In the EU, the career path of women is referred to as a "leaky pipe." At each stage up the career path, from university graduation to the very top, the percentage of women declines until finally very few of them come out of the pipe at the other end. This phenomenon is found not only in women's academic career paths, but in corporate ones as well. Various research is now being carried out to uncover its major causes.

As in the EU, in Japan it is necessary to analyze obstacles to the career paths of female researchers, through statistical surveys of employment forms and work duties and conditions, by tracing the career paths of women who hold university and graduate school degrees in scientific and technical fields, and by carrying out interviews with female researchers in corporations.

Policies regarding issue (3)

- Clarify the agency responsible for "women and science"

A government agency should be designated to function to plan and carry out survey research and research grant support and research programs including statistical surveys related to the development and support of women as science and technology human resources.

In the European Commission, since 1998 the Women and Science Unit of Directorate C of the Research Directorate-General has been carrying out such policies[10].

- Focus on women as science and technology human resources in the Third Basic Plan

In the Third Basic Plan to open in 2006, establish the category "Developing, utilizing, and supporting women as science and technology human resources" and clarify its place in science and technology policy.

Notes

*1 The definition of "researcher" in this report
In the Report on the Survey of Research and Development (Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications), "researcher" is defined as "a person who has graduated from a college other than a juniror college (or who has at least the equivalent amount of specialist knowledge) and who carries out research on a specific research theme." "Research" is defined as "creative efforts and pursuits to obtain new knowledge about things, functions, phenomena, etc., or to open the way to new applications of existing knowledge." That definition is identical to the one used in the Frascati Manual, an international statistical guideline. The definition of "researcher" is also therefore also broad, and for the purpose of this article "researchers" includes "engineers." However, technicians and others who perform support or routine work are not included among "researchers."

*2 Number of researchers
940,000 in the 15 EU countries, 1.22 million in the United States, and 660,000 in Japan (1999 statistics).

References

[1] Women in Industrial Research, A wake up call for European Industry, Science and Society, EC (2003).

[2] Women in Industrial Research, Analysis of statistical data and good practices of companies, Science and Society, EC (2003).

[3] Women in Industrial Research, Good

practices in companies across Europe, Science and Society, EC, (2003).

[4] Future Opportunities, generated by diversity in higher education and training, Gender mainstreaming as an impetus and driving force behind the course reform in computer science, engineering and natural sciences, International conference (Munich), February 2002, Bundesministerium für Bildung und Forschung.

[5] National Policies on Women and Science in Europe, The Helsinki Group on Women and Science, Science and Society, EC (March 2002).

[6] She Figures 2003, Statistics and Indicators, Women and Science, Science and Society, EC (2003).

[7] Frascati Manual, OECD (2002).

[8] Sally Goodman, "Europe is pushing to get more women scientists into industry and academia, but can the commission legislate for gender equality?" Nature 426, 210-211 (2003).

[9] The Scientist Readers' survey : www.the-scientist.com/industry/topten.html.

[10] Organization of the European Commission Research Directorate-General: http://www.europa.eu.int/comm/dgs/research/index_en.html.

[11] Survey of Research and Development (Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications)

[12] FY 2002 Survey on Research Activities of Private Companies (Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology) (in Japanese)

[13] Report on Fiscal 2002 School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology)

[14] Report on survey of full-time equivalency data in universities (Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology) November 2003. (in Japanese)

(Original Japanese version: published in December 2003)